(40)

(12) UK Patent Application (19) GB (11) 2 252 911 (13) A

(43) Date of A publication 26.08.1992

(21) Application No 9125893.9

(22) Date of filing 20.04.1989

Date lodged 05.12.1991

(30) Priority data
(31) 184088 (32) 20.04.1988 (33) US
263290 22.10.1988

(62) Derived from Application No 8908993.2 under Section 15(4) of the Patents Act 1977

(71) Applicant
Irwin Albert Small
6861 Orinoco Circle, Birmingham, Michigan 49010, United States of America

(72) Inventor
Irwin Albert Small

(74) Agent and/or Address for Service
Withers & Rogers
4 Dyer's Buildings, Holborn, London, EC1N 2JT, United Kingdom

(51) INT CL[5]
A61C 8/00

(52) UK CL (Edition K)
A5R RDJ

(56) Documents cited
GB 2217994 A US 4968250 A US 4917604 A

(58) Field of search
UK CL (Edition K) A5R RDJ RDN RDX
INT CL[5] A61C 8/00
Online databases: WPI

(54) **Drill guide for implanting mandibular compression staples**

(57) A drill guide apparatus has a plane guide 116 and drilling barrel (118) for proper alignment of a staple 10 for compressive implantation in the mandibular jaw. The staple 10 (described and claimed in GB 2217994 A) is provided with a plurality of parallel transosteal pins 28 which are mounted on a mounting axis which extends in a direction parallel to the axis of compression. The plane guide 116 has a curvilinear aperture 130 to extend around the jaw bone for forming a planar mating surface on the bone with a grinding tool 136. The drilling barrel 118 accepts a plurality of removable sleeves 164 for guiding drill bits 162 of different sizes.

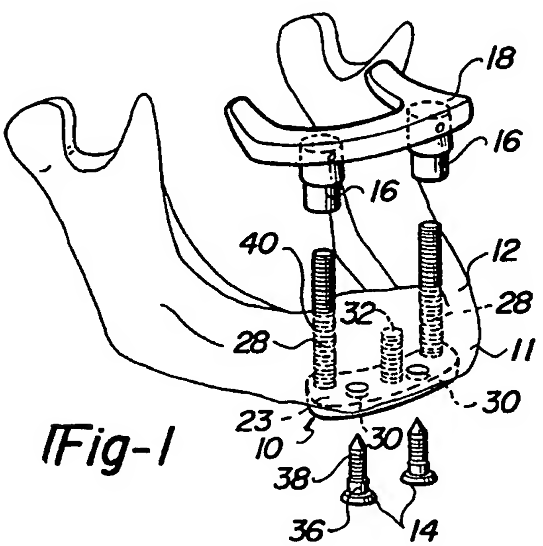


Fig-1

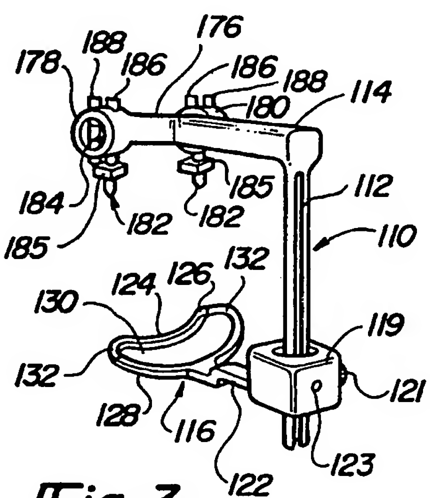


Fig-3

GB 2 252 911 A

The date of filing shown above is that provisionally accorded to the application in accordance with the provisions of Section 15(4) of the Patents Act 1977 and is subject to ratification or amendment.

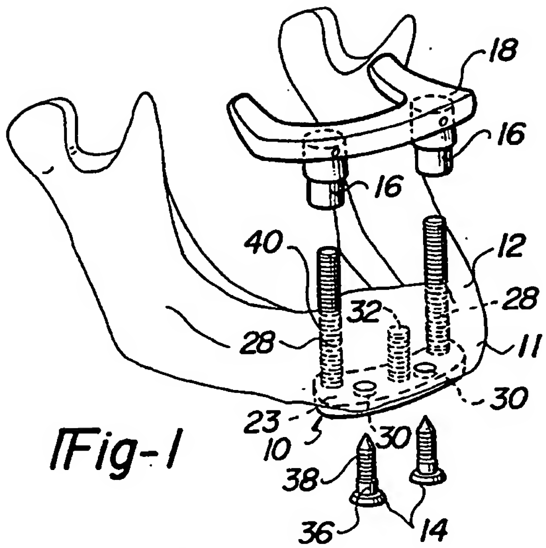


Fig-1

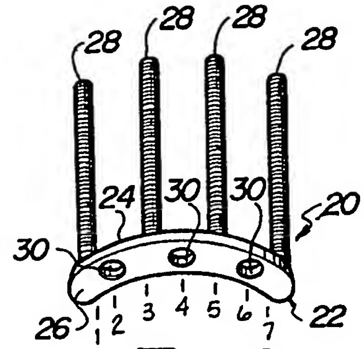


Fig-2

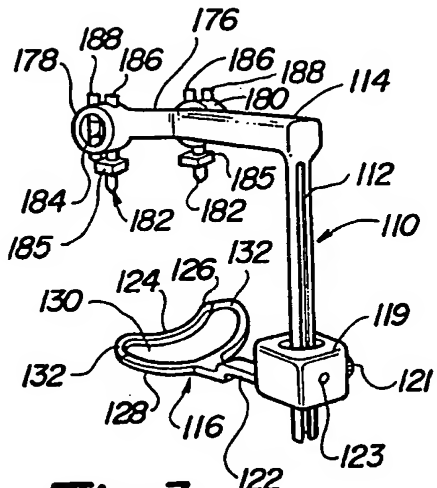
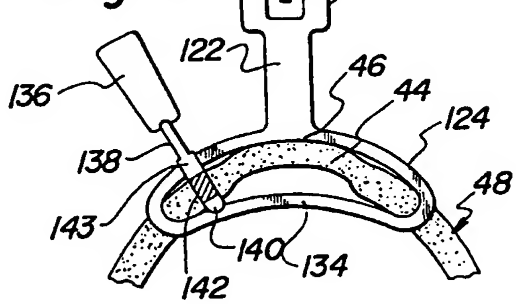


Fig-3

Fig-4



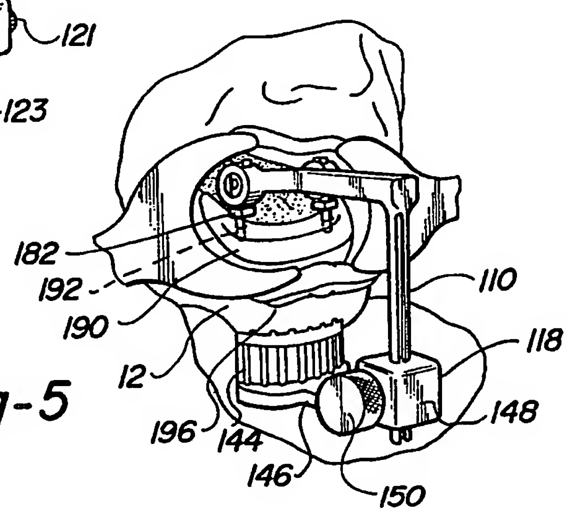


Fig-5

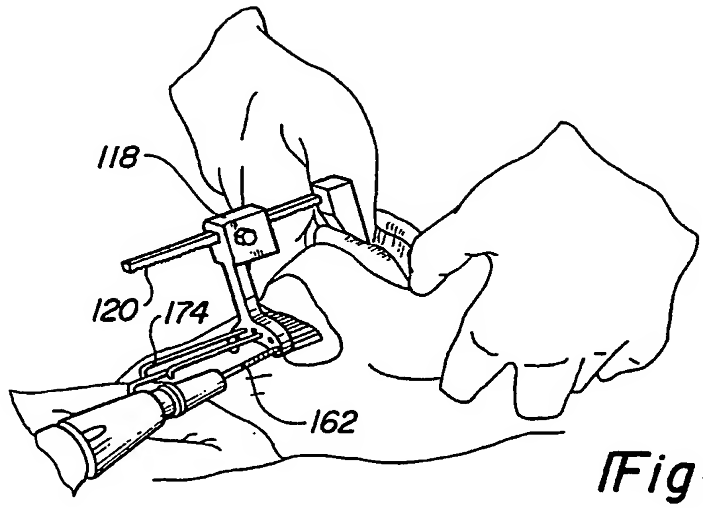


Fig-6

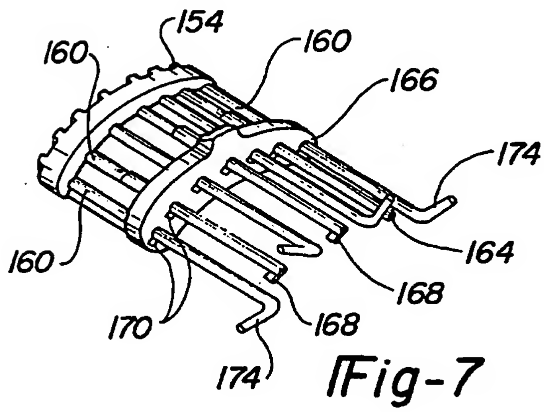


Fig-7

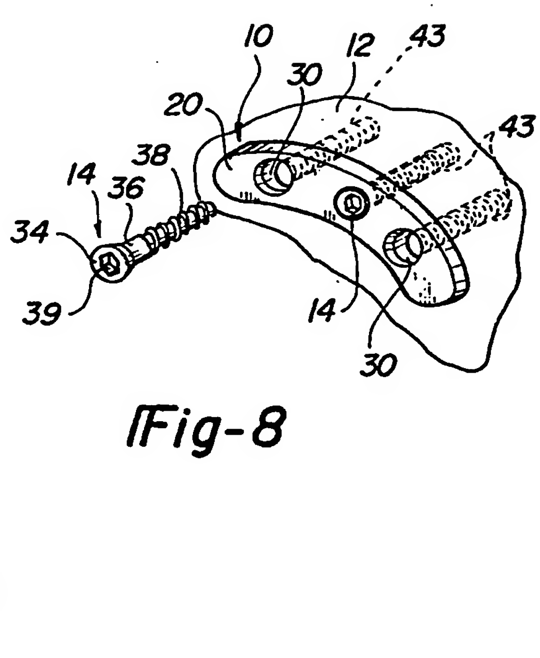


Fig-8

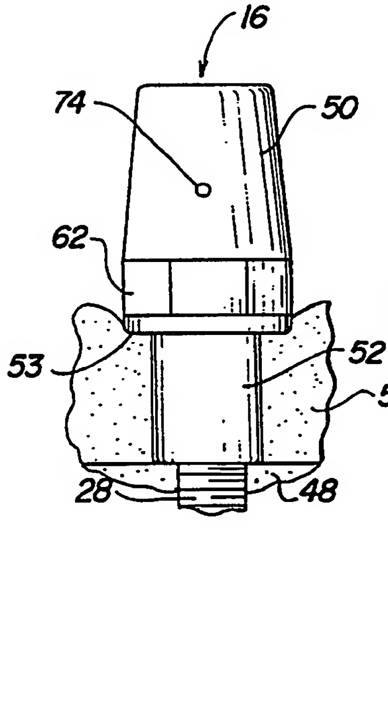


Fig-9

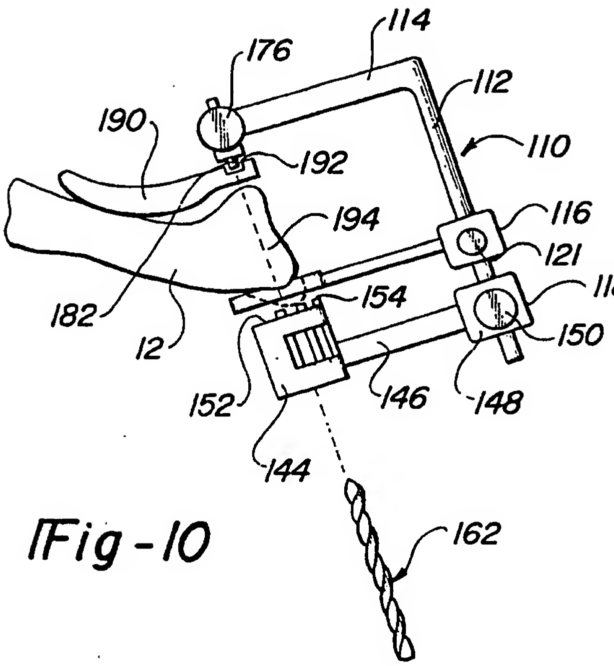
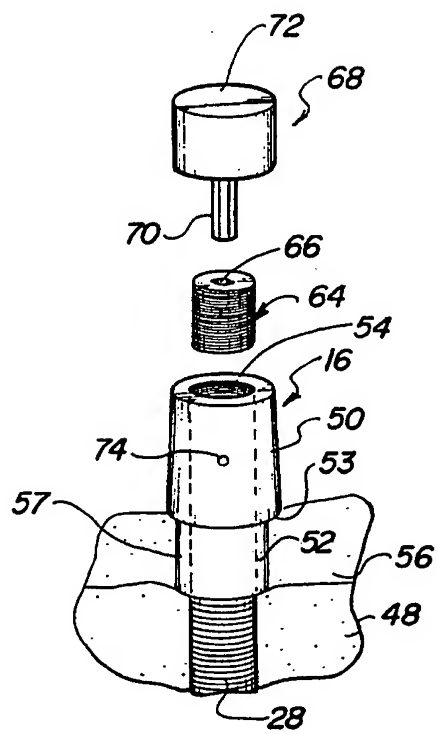


Fig-10



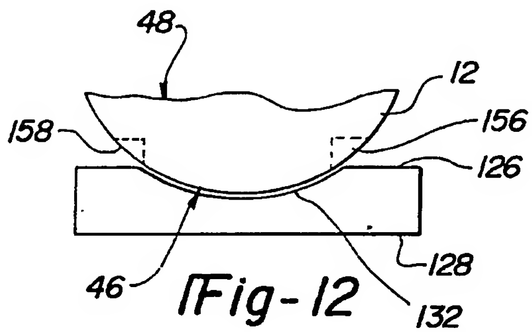


Fig-12

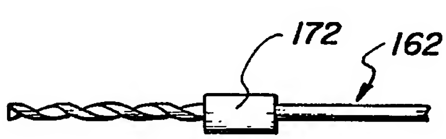
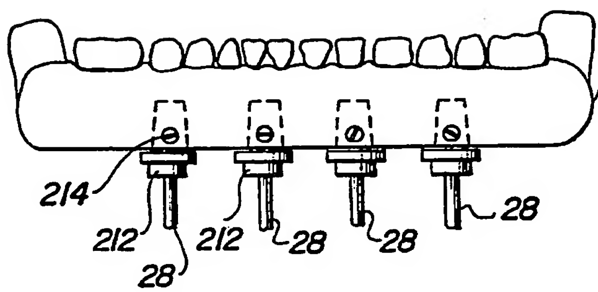
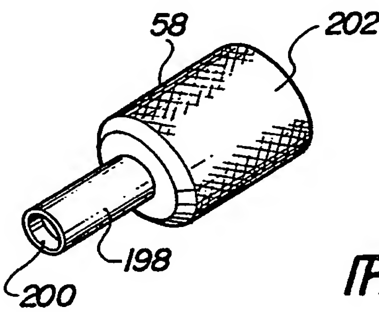


Fig-11

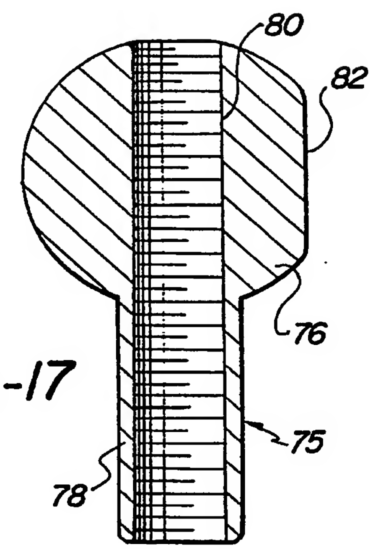
Fig-13



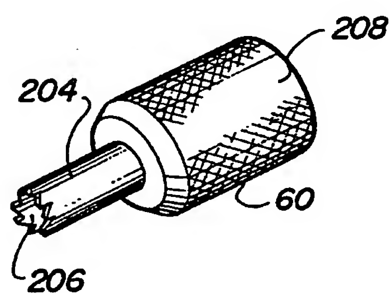
IFig-14



IFig-15



IFig-17



IFig-16

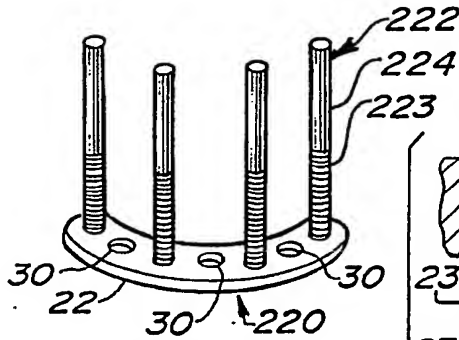


Fig-18

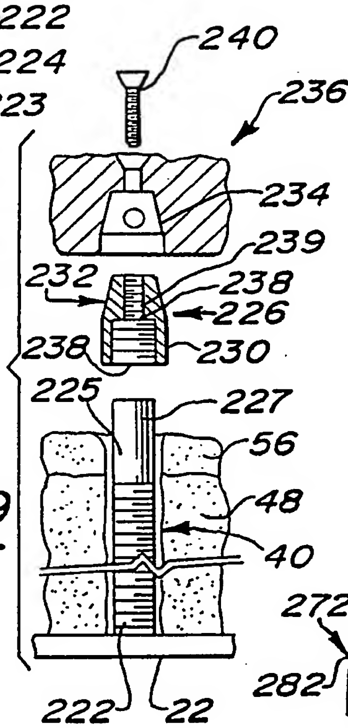


Fig-19

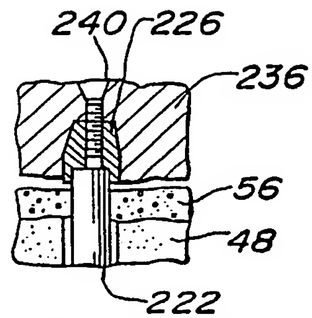


Fig-20

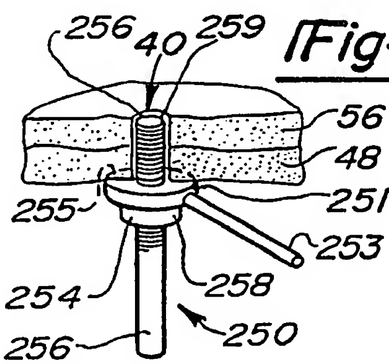


Fig-21

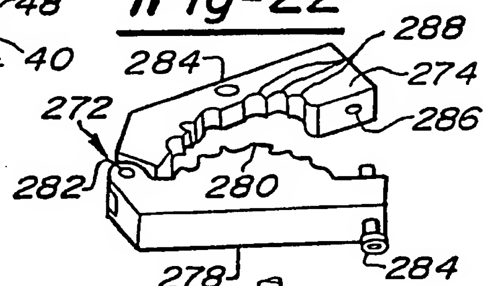


Fig-22

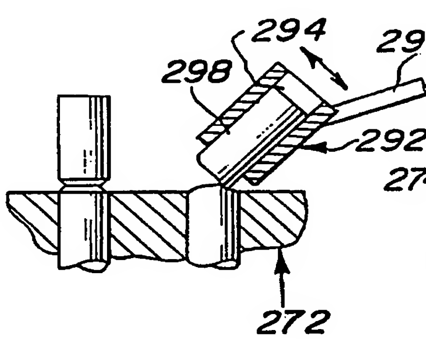


Fig-24

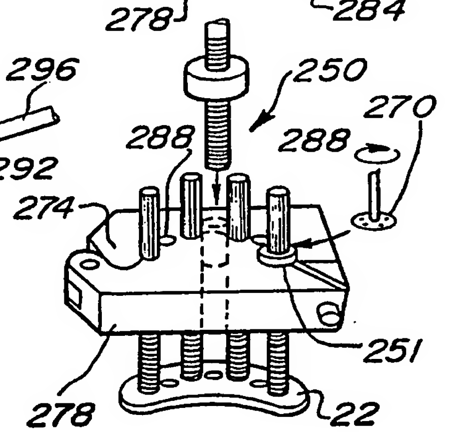
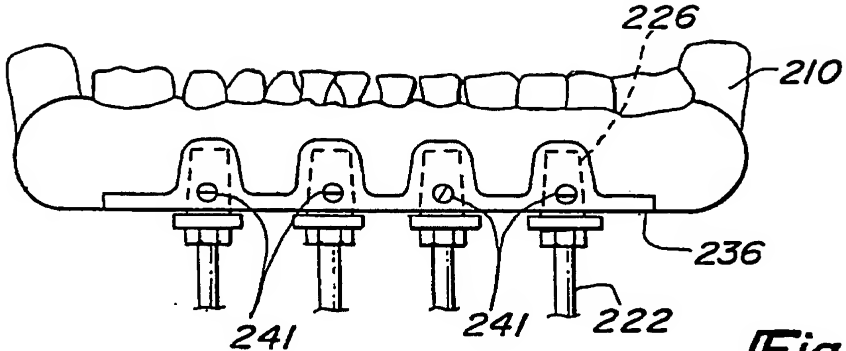
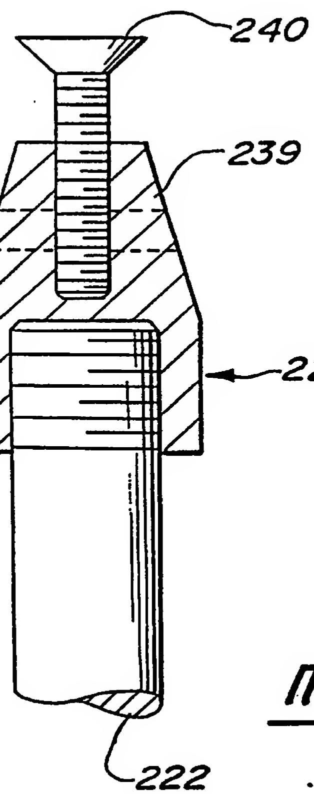


Fig-23



IFig-25



IFig-26

APPARATUS FOR INSERTION OF A COMPRESSION STAPLE

The present invention relates to a drill guide assembly for use during implantation of a staple into the mandibular jaw.

Mandibular staples such as disclosed in Applicant's prior patents, U.S. Patent Nos. 3,414,975, 3,664,022 and 3,895,444, are known for implantation in a mandible or lower jaw. The mandibular staple has been implanted for rehabilitation of various types of mandibular deformities. These deformities, which occur through aging or wasting away of bone tissue, prevent the anchoring of a dental appliance against accidental dislodgement. The mandibular staple is implanted to provide additional support against dislodgement of the dental appliance or prosthesis.

Applicant's prior staple, such as disclosed in Patent No. 3,895,444, features a curvilinear support plate, a pair of threaded transosteal pins and a plurality of mushroom shaped fasteners. The shape of the support plate conforms to the curvilinear shape of the front end of the jaw bone. The pair of threaded transosteal pins extend outwardly from the support plate to extend through the jaw bone to receive threaded support nuts.

The plurality of mushroom shaped fasteners extend upwardly from the plate for insertion into holes drilled in the jaw bone for securing the staple to the jaw bone. The staple is secured to the jaw bone when the penetrated subcutaneous tissue and bone surrounding the pins and mushroom shaped fasteners grows outwardly. The tissue eventually grows into a porous or pitted bioceramic coating on the staple to homogeneously lock the staple to the jaw bone. A dental appliance may be removably affixed to the support nuts.

Applicant's prior Patent No. 3,664,022 featured a drill guide having a jig bore adapted for abutment with the jaw bone and a yoke member having a pair of spaced apart guide pins. The jig bore is movable on a post to abut the curved front end of the jaw bone to permit the drilling of a plurality of throughbores and blind bores in the mandibular jaw bone, for accepting the pair of pins and the plurality of mushroom shaped fasteners of the staple. The guide pins of the yoke extend to contact a template extending over the upper surface of the jaw.

Applicant's prior staple provides support for retaining a removable prosthesis or appliance. However, the prior drill guide and method of insertion provide an alignment of the transosteal pins of the staple which is substantially angled with respect to a lateral plane of the dental prosthesis and an axis of compression of the jaws. Thus, the dental prosthesis is required to accept the staple at an angle to the lateral plane. Formation of the dental prosthesis in this manner is both time consuming and expensive.

In his Application No. 8908993.2 (GB 2217994A) the present Applicant has described and claimed a staple assembly for implantation in a mandibular jaw for supporting a dental prosthesis, said staple assembly comprising a staple having a base plate and a plurality of parallel threaded transosteal pins, said base plate having a flat upper surface and a lower surface adapted to flatly mate with a flat surface on the inferior border of said mandibular jaw, said base plate having at least two circular openings extending through said base plate, each of said plurality of transosteal pins being of a length to extend through said mandibular jaw and having one end affixed to said base along a predetermined arc ascribed on said upper surface and having a free end portion extending through said mandibular jaw whereby said free end portions are positioned in a predetermined parallel spaced apart relationship, at least two self-tapping lag screw members having head portions, each of said at least

two lag screw members being adapted to extend through a respective one of said at least two openings in said base plate to threadably engage a bone portion of said mandibular jaw whereby said flat upper surface of said base plate is compressively mated with said flat surface of said inferior border of said mandibular jaw when said screw members are tightened and said head portions engage said lower surface of said base plate and a plurality of nuts each having an axial bore for mounting on said free end portion of a respective one of said transosteal pins.

According to the present invention, there is provided a drill guide assembly for use with a drill and a grinding apparatus in the implantation of mandibular staples, said drill guide assembly being adapted for positioning and drilling a plurality of throughbores and a plurality of blind bores in spaced apart parallel alignment with a mounting axis through a mandibular jaw with a drill bit, said drill guide assembly comprising an elongated post having a pair of ends, a yoke member mounted to one of said pair of ends of said post for supporting said drill guide assembly in an upper position above said jaw, a plane guide detachably mounted to said post, said plane guide having a loop portion having a flat guide surface extending on a plane, said loop portion defining an aperture adapted for receiving a portion of said jaw with a protruding portion projecting beyond said guide surface within, whereby a planar mating surface may be formed on said jaw by grinding said projecting portion to extend along said plane, said planar mating surface extending normal to said mounting axis, means for guiding said drill bit for forming a plurality of apertures in said jaw bone, said means for guiding being detachably mounted to said post.

The present invention provides for alignment of the mounting axis of the staple generally parallel to the compressive axis of the patient's lower mandibular jaw.

Additionally, the staple is compressively mounted to the mandibular jaw to provide a base for vertical loading to permit the mounting of a fixed prosthesis. The transosteal pins are thus, maintained in parallel spaced apart relationship and aligned generally normal to the lateral plane of the prosthesis to further facilitate in the production and mounting of the prosthesis.

The plane guide provides a template for creating a planar mating surface on the jaw bone. The means for guiding preferably comprises a drilling chamber having a plurality of teeth to lock the drill guide in position in grooves formed in the jaw bone to prevent wandering of a drill bit during the drilling operation and to improve the alignment of the holes formed for the staple, thus facilitating the insertion of the staple into the jaw.

These and many other advantages of Applicant's invention for use with a fixed mandibular staple will be apparent to those skilled in the art.

In the accompanying drawings:

Fig. 1 is an exploded view of a mandibular jaw with a two transosteal pin staple, sleeve nuts and a prosthesis;

Fig. 2 is a perspective view of a four transosteal pin staple;

Fig. 3 is a perspective side view of a drill guide assembly according to the invention having a plane guide in position;

Fig. 4 is a plan view of the plane guide positioned on the inferior border of the mandibular jaw for grinding with a burring tool;

Fig. 5 is a perspective view of the drill guide assembly with a drilling chamber in position for drilling;

Fig. 6 is a perspective view of the drill guide in position as used during a drilling operation in the implant procedure;

Fig. 7 is a perspective view of the drilling chamber for the drill guide;

Fig. 8 is an exploded view of a staple in position in the mandibular jaw;

Fig. 9 is a side view of a sleeve nut mounted in position on a transosteal pin;

Fig. 10 is a side view of the drill guide assembly in position for use with a plane guide and a drilling chamber;

Fig. 11 is an exploded view of a nut, set screw and insertion tool;

Fig. 12 is a side view of an end of a loop of the plane guide in position on the inferior border;

Fig. 13 is a top view of a drill bit for use with the drilling guide;

Fig. 14 is a perspective view of a prosthesis in position upon the transosteal pins of a compression staple;

Fig. 15 is a perspective view of a gingival cutter;

Fig. 16 is a perspective view of a bone crest leveller;

Fig. 17 is a perspective view of an alternative form of sleeve nut mounted on a transosteal pin;

Fig. 18 is a perspective view of an alternative form of staple;

Fig. 19 is an exploded view of a self-tapping cap nut, staple and superstructure;

Fig. 20 is a sectional view of the superstructure and cap nut in position on the staple;

Fig. 21 illustrates a depth gauge;

Fig. 22 is a perspective view of a clamping rack;

Fig. 23 is a perspective view of the clamping rack in position for notching of the staple;

Fig. 24 is a sectional view of a breaking tool in position during use;

Fig. 25 is a perspective view of a dental appliance supported by a superstructure and staple;

Fig. 26 is a front view of a self-threading cap nut.

With reference to the drawings, a compression staple is shown in two forms. A first form comprises a fully threaded compression staple as shown in Fig. 1 and 2. A four transosteal pin staple 20 is shown in Fig. 20 and a smaller two transosteal pin staple 10 is shown in Fig. 1. A second form comprises a smooth surfaced compression staple 220 shown in Fig. 18.

In Fig. 1, the two transosteal pin staple 10 is shown implanted through a mandibular jaw 12.
The staple 10 is secured compressively in position by two self-tapping lag screws 14. Sleeve nuts 16 are threaded

on each transosteal pin 28 to provide support for a bridge structure 18 to which a prosthesis may be affixed. The two transosteal pin staple is suitable for use in the jaws of adolescents and smaller adults.

The four transosteal pin staple 20 shown in Fig. 2 has a curvilinear shaped base plate 22 having a flat upper surface 24 and a flat bottom surface 26. Each of four transosteal pins 28 is mounted to extend upwardly in a direction normal to the plane of the upper surface 24 of the base plate 22. Each transosteal pin 28 has a length greater than the combined thickness of the jaw bone and gingiva, to threadably accept a sleeve nut 16 as best shown in Fig. 9. Each transosteal pin 28 is located at positions shown at 1, 3, 5 and 7 on the base plate 22 as indicated in Fig. 2. The transosteal pins and base plate 22 are formed of a suitable corrosion resistant material such as a high strength titanum alloy (TIV). The transosteal pins 28 extend along parallel axes and are affixed to the base plate 22 in a suitable manner such as laser welding. The surface of the staple may be coated with a bioceramic material such as aluminum oxide or hydroxylapatite to improve interaction with the bone.

Each of three circular bores 30 extend through the base plate 22 at positions 2, 4, and 6 indicated in Fig. 2, and are, thus, positioned between each pair of the four transosteal pins 28. Each of the three bores 30 is formed to accept one self-tapping lag screw 14.

Each lag screw 14 has a cylindrical portion 36 extending between a head 34 and a threaded end portion 38. The threaded end portion 38 is provided with self-tapping type threads. The head 34 is provided with an opening such as as a hexagonal shaped indentation 39 for accepting a shaft of a driver such as an Allen wrench or Spline screwdriver (not shown) for threadably advancing the lag screw 14 into the jaw bone.

As set forth more fully below, the compression staple 10 is implanted in the mandibular jaw by inserting each transosteal pin 28 through a respective throughbore 40, as shown for the two pin staple in Fig. 1, drilled through the jaw. A flat mating surface 44 is formed on an inferior border 46 of the jaw bone 48 as shown in Fig. 4.

As shown in Fig. 8, the four pin staple 20 is inserted in the jaw so that the upper surface 23 of the base plate 22 securely abuts the mating surface 44 to prevent displacement of the staple during chewing. One lag screw 14 is then inserted through each of the three circular bores 30 in the base plate 22 and threadably driven into a plurality of blind bores 43 formed in the mandibular jaw 12 to compressively connect the staple to the jaw. Each blind bore 43 has a diameter smaller than the diameter of the lag screw 14, for instance, 2 mm, to permit self-tapping threading of the lag screw 14 in the blind bore 43. The blind bores are drilled to a predetermined depth of, for instance, 9, 12 or 15 mm, depending on the length of the lag screw 14 being used.

As shown in Fig. 11, after the staple has been inserted, the sleeve nut 16 is threadably mounted on each transosteal pin 28. Each sleeve nut 16 has a frusto-conical head 50 and a sleeve portion 52 extending outwardly from the head 50. An annular surface 53 extends between the head 50 and sleeve portion 52. Flat surfaces 62 may be formed on the head 50 as shown in Fig. 9. In a preferred form, six flat surfaces 62 formed in the shape of a hexagon are positioned for use with a tool such as a socket wrench for threading the sleeve nut 16 onto the transosteal pin 28. The sleeve nut has a threaded throughbore 54 for engaging the threads of the transosteal pin 28. The sleeve portion 52 has a predetermined length generally equal to the

thickness of the layer of gingiva 56 extending above the bone 48 of the mandible. As will be discussed more fully below, a cavity 57 is formed through the gingiva 56 to accept the sleeve with a trephine 58, as shown in Fig. 15. If necessary, a portion of the top surface of the bone 48 is further removed with a crest leveler 60, as shown in Fig. 16. The crest leveler 60 removes bone to provide a flat surface, so that the annular surface 53 of the head of the nut contacts gingiva 56 and the end surface of the sleeve portion 52 rests firmly against the bone 48 of the jaw.

After the final position of the nut 16 has been established, the sleeve nut 16 is removed from the transosteal pin 28 and the pin shortened so as not to extend fully through the throughbore 54 of the nut 16.

As shown in Fig. 11, a threaded cylindrical plug 64 having a hexagonally shaped bore 66 extending axially is inserted into the threaded throughbore 54 at the head of the nut to contact the top of the transosteal pin 28 and lock the plug 64 and the nut 16 in position on top of the transosteal pin 28. The plug 64 is threadably advanced in the nut by turning the plug with a driving tool 68 having a hexagonally shaped finger 70 extending outwardly from a handle 72. The finger 70 is adapted to mate with the hexagonally shaped bore 66 of the plug 16. After the plug 64 is tightened against the top of the transosteal pin 28, a set screw 74 extending through the plug may be advanced radially through the nut 16 to engage the plug 66 to lock the nut and plug together. In this manner, the nut is lockingly affixed to the transosteal pin to aid in maintaining the staple (10 or 20) in position within the jaw.

An alternative form of sleeve nut is shown in Fig. 17, a nut 75 having a spherically shaped head 76 with a sleeve 78 extending outwardly from the

head. A threaded throughbore 80 extends axially through the nut 75. A flat surface 82 is formed on the spherically shaped head 76 to extend parallel with the axis of the nut 75 to provide a surface for seating a set screw 214 of a denture 210 (shown in Fig. 14). The nut 75 may be locked into position on the transosteal pin 28 in the same manner as described above for the sleeve nut 16.

The four pin staple 20 is, thus, compressively implanted. The four sleeve nuts 16 affixed to the staple provide a sufficient platform for permanent fixation of a dental appliance. However, the smaller two pin staple 10 does not provide a sufficient base to support a fixed attachment of an appliance. Therefore, the four pin staple should be used whenever the jaw bone is sufficiently large to accomodate one, in order to provide a base for affixed attachment of a prosthesis.

If the arc of the jaw is too small to allow proper drilling of holes at positions 1 and 7 for the outermost transosteal pins of the four pin staple, the two pin staple should be used. A base plate 23 of the two pin staple 10 is similar to the base plate 22 of the four pin staple; however, the base plate extends only between the base plate positions 2 to 6, as indicated in Fig. 2, for the four pin staple. Positions 2 through 6 of the four pin staple have equivalent positions on the two pin staple. As shown in Fig. 1, two transosteal pins 28 are positioned at positions 2 and 6, respectively. A short threaded pin 32 is positioned at position 4. The short pin 32 does not extend through the jaw bone. Two circular apertures 30 are formed at positions 3 and 5, respectively, for the lag screws 16.

The second form of compression staple 220 is shown in Figs. 18 and 19. The smooth surfaced

compression staple 220 has four transosteal pins 222 with smooth end surfaces 224 to prevent irritation of the gingiva and to facilitate coating of the end surfaces with bioceramic or biocompatible polymer material. This material provides a pitted or porous surface for adhesion of the gingiva tissue or bone to the staple. The alternative staple 220 is identical to the staple 20 described above with the exception of the smooth end surfaces 224 of the transosteal pins which are coated with a bioceramic or biocompatible polymer. Similarly, the smooth ended staple 220 may be formed in either two or four transosteal pin sizes. The smooth ended staple 220 is formed of the same materials and in the same manner as discussed above for the compression staple.

The smooth ended staple 220 differs from the compression staple 20 in that the free ends of each of the transosteal pins 222 have smooth end surfaces 224 extending from a threaded lower portion 228, as shown in Fig. 18. The threaded lower portion 228 extends a distance generally equilavent to the thickness of the bone 48 of the mandible (Fig. 19). The threaded portion is formed to secure engagement with bone which is reformed in the throughbores 40 after implantation of the staple. The threaded lower portion 228 should have a length of approximately 9 mm.

The smooth end surface 222 extends from the threaded lower portion 228 of each transosteal pin has a diameter equal to the outer diameter of the threaded lower portion. The smooth end surface is provided to extend through the gingiva and reduce irritation of the gingiva. In order to improve the retention of the staple to the mandible, the smooth ends of the transosteal pins may be covered with a bioceramic or biocompatible polymer coating 225. The coating is pitted or porous to interact

with the gingival tissue and bone. Each transosteal pin has a portion 227 extending above the gingival crest approximately 5 mm to receive a self-threading cap nut 226.

As shown in Fig. 19, the cap nut 226 has a cylindrical lower portion 230 and a frustoconical upper portion 232 adapted to be matingly received in a bore 234 formed in the super-structure 236. A threaded bore 238 is formed internally within the lower portion 230. The threaded bore 238 is provided with suitable threads for self-threading the cap nut 226 onto the smooth surface 224 of each transosteal pin 222. An axial bore 239 is formed in the upper portion 232 of the cap nut to receive a screw 240 for securing the superstructure 236 to the cap nut, as best shown in Fig. 20.

As shown in Fig. 25, the appliance 210 and super-structure may be affixed directly on the cap nut with a screw 241 as shown in Fig. 25 which is inserted into a radial bore 239 formed in the cap nut. Alternatively, the cap nut could be provided with threads (not shown) on the outer surface for threadingly affixing the cap nut to the superstructure. It is also contemplated that the cap nut could be glued in place on the transosteal pin.

The cap nut is threadedly advanced approximately 3 mm on to the smooth surface of the transosteal pin 222. A die for cutting threads on the end portion of each transosteal pin may be used to facilitate engagement of the cap nut with the transosteal pin. The cap nut may be tightened by using a tool which is inserted into the axial bore 238. A gap of approximately 2 mm extends above the crest of the gingiva 56 below the cap nut and superstructure for cleaning. The superstructure may be prefabricated for use with the staple. In order to utilize a prefabricated superstructure, the placement and

parallel alignment of the transosteal pins must remain constant from staple to staple. The bores 234 of the superstructure are centered on an arc identical to the arc "A-A" (Fig. 18) extending through the transosteal pins and are spaced the same distance apart.

With reference now to Figs. 3 and 4, aligning and drilling of the respective bores for implantation of the staple through the jaw bone 10, presents a significant problem in the accurate implantation of the compression staple 10. The mounting axis of the staple must be as close as possible to normal to a lateral axis of the prosthesis. The flat mating surface 44 must be accurately positioned on the inferior border 46 of the jaw to permit abutting contact with the upper surface 24 of the base plate 22 of the staple. The flat mating surface 44 provides support against displacement of the staple and permits compressive attachment of the base plate to the jaw 12 by way of the lag screws 16. Additionally, the plurality of throughbores 40 and plurality of blind bores 43 must be properly aligned so as not to have the staple bind or otherwise damage the jaw bone or to cause subsequent later problems and injury.

It is, therefore, of primary importance to properly locate and form the mating surface for the staple. Additionally, the respective bores must be drilled such as to be in perfect alignment with and corresponding to the spacing of the transosteal pins 28 and circular apertures 30 of the staple. It is, likewise, primarily essential that the bores drilled through the jaw bone be accurately located with respect to the jaw bone centerline and inwardly of the open nerve centers of the jaw bone.

For this purpose there is provided the

improved drill guide assembly, in accordance with the present invention, generally indicated at 110, as shown in Fig. 10. The assembly 110 consists of an elongated post 112 which at an upper end stationarily supports an upper arm 114 and removably supports a plane guide 116 and a drilling chamber 118 which are slidable along the post 112 towards or away from the upper arm 114. Both the plane guide 116 and drilling chamber 118 are movable and removable along the post 112. As disclosed in my prior Patent No. 3,664,022, which is incorporated by reference herein, the post 112 has an inner surface 120 (Fig. 6) having back teeth which are engaged by a gear (not shown) suitably supported for rotation within an enlarged rear portion 119 (Fig. 3) of the plane guide.

Extending from the enlarged rear portion 119 of the plane guide, as shown in Fig. 3, is a bar 122 supporting a loop 124 having an upper surface 126 and lower surface 128. The loop 124 forms a curvilinear aperture 130 conforming to the shape of the base plate 22 of the four pin staple, however, having dimensions slightly greater than the staple. The aperture 130 is formed to accept a lower protruding portion of the jaw within. A curved surface 132 is disposed along the upper surface 126 at each end of the loop 124. The curved surface 132 has a radius to accept the radius of the jaw bone in order that the plane guide 116 can be closely aligned on the jaw bone. The lower surface 128 of the plane guide forms a flat guiding surface 134 for a burring tool 136 to permit reduction of any portion of the lower jaw protruding through the aperture, as shown in Fig. 4. The guiding surface 134 extends on a plane normal to the longitudinal axis of the post 112 and mounting axis 194 to permit formation of the mating surface 44 on the jaw for accepting the upper surface 24 of the base plate 22 of the staple.

The burring tool 136 has a bit 138 having a smooth tip portion 140 and a knurled grinding portion 142 extending inwardly from the tip portion 140. A smooth cylindrical portion 143 extends inwardly from the grinding portion 143. The grinding surface has an axial length less than the width of the aperture 130 of the plane guide 116. The tip portion 140 and cylindrical portion 143 are adapted to ride along the guiding surface 134 of the loop to facilitate grinding of the bone to produce the flat mating surface 44 for the staple as shown in Fig. 4.

The plane guide 116 may be moved into position for alignment of the mounting axis or grinding and may be removed as desired. When the plane guide is in position, a set screw 123 may be threaded in the enlarged rear portion 119 to contact the post 112 to lock the plane guide in position.

As shown in Fig. 5, the drilling chamber 118 is movably supported along the post 112 by a rear portion assembly 148 in the same manner as disclosed above for the plane guide 116. A hand wheel 150 acts to move a gear (not shown) for movement of the drilling chamber along the post. An arm 146 extends from the rear portion assembly of the drilling chamber 118 in a direction normal to the axis of the post 112 to support a transverse curvilinear shaped barrel 144. The barrel 144 has a flat surface 152 extending on a plane parallel with the guiding surface 134 of the plane guide 116. A plurality of teeth 154 extend outwardly from a peripheral edge of the flat surface 152 of the barrel 144 of the drilling chamber. The plurality of teeth 154 extend to engage the jaw bone and lock the barrel 144 of the drilling chamber in place against the mating surface 44 formed with the plane guide 116. In the event the flat surface 52 of the drilling chamber cannot be positioned

flush against the mating surface 44 because of abutment of the plurality of teeth against the jaw bone, an additional labial groove 156 (Fig. 12) with a radius corresponding to the radius of the peripheral edge supporting the plurality of teeth of the drilling chamber may be formed on the jaw to accept the teeth. In some cases, a slight lingual groove 158 may be necessary. The plurality of teeth 154 are adapted to bite into the lower surface of the jaw bone in order to lock the barrel in position and to prevent slipping or movement during the drilling operation.

The barrel 144 of the drilling chamber, as shown in Fig. 3, has seven apertures 160 adapted to receive a plurality of sleeves 164 for guiding the bit 162 of a drill for drilling holes in the mandibular jaw bone 10 for implantation of the staple. The seven apertures correspond to positions 1 to 7 of the four pin staple 20 shown in Fig. 2. The seven apertures, thus, correspond in spacing and number to the spacing and number of transosteal pins 28 and circular openings 30 of the four pin staple 20 and are adapted for drilling the bores associated with the positions 1-7. The barrel is also adapted to drill the bores for the two pin staple since positions 2 through 6 for the two pin staple correspond in position to positions 2 through 6 of the four pin staple.

Each of the plurality of sleeves 164 has an outer diameter corresponding to the diameter of each aperture 160 extending through the barrel of the drilling chamber. Each sleeve has an inner diameter corresponding to the desired diameter of the bore required to be drilled. Thus, when drilling the plurality of throughbores for the transosteal pins, a sleeve having an inner diameter corresponding to a 7/64 drill bit is provided. Additionally, sleeves having an inner diameter

corresponding to the drill bit sizes for the blind bores for the lag screws are provided. As shown in Fig. 7, on the outer surface at one end of each sleeve 164 is positioned an arm or key 168 to engage a keyway 170 formed on the lower surface 166 of the barrel of the drilling chamber to prevent movement or rotation of each sleeve when used for drilling. When drilling, a sleeve having the appropriate inner diameter is inserted in the designated position in the barrel. The inner diameter is selected in accordance with whether a throughbore is being drilled for a transosteal pin or a blind bore is being drilled for the lag screws. Thus, four sleeves having an appropriate inner diameter are positioned in positions 1, 3, 5 and 7 for drilling the throughbores for the four pin staple. The sleeves are locked in position by the key and keyways. As shown in Fig. 10, an appropriately sized drill bit 162 is then inserted through the sleeve for drilling the throughbores. As shown in Fig. 13, the depth of the hole is controlled by a stop 172 affixed to the drill bit 162, thereby establishing the depth to be drilled. In drilling the blind bores for the lag screws, one set of sleeves must be used to drill the blind bore for the threads of the lag screw and a separate set of sleeves having a larger inner diameter are used for counter-sinking the cylindrical shaped portion of the lag screw.

The curvilinear shape of the barrel 144 of the drill guide is adapted to be received within the aperture 130 of the plane guide 160, if so desired, for use during alignment of the mounting axis 194. The curvilinear shape of the barrel corresponds to the curvilinear shape of the support plate of the staple. As seen in Fig. 5, the rear of the barrel is slotted from end to end, intersecting the apertures 160 to provide a lateral opening for access to each of the apertures for the

plurality of sleeves 164.

As shown in Fig. 3, the front end of the upper arm 114 supports a yoke member 176 which extends transversely of the arm 114 to both sides thereof. Both outer ends of the yoke member are formed cylindrically at 178 and 180 and each outer end has a pair of pins having an inner pin 186 and an outer pin 188 to support two director rods 182 for extension downwardly towards the barrel of the drilling chamber. The pins 181 are yieldably supported for relative longitudinal up or down movement at opposite ends of a centrally pivoted see-saw lever 184 which extends longitudinally through the yoke member 176 and is pivotally secured therein at its center. As disclosed in my prior patent, when one pin is moved upwardly, the other opposite director rod is forced to move downwardly and vice-versa. This pivotal reciprocating arrangement of the pins 186 and 188 and director rods 185 is provided to accomodate for uneveness in the jaw bone thickness. The pair of inner pins 186 define an inner position and the outer pins 188 define an outer position for the director rods. Both director rods 182 are threadably mounted to the pins by an attachment member 185 to either the inner position or the outer position pins depending on which staple is being used. The inner and outer positions permit offsetting the director rods from the end of the drill bit when drilling the throughbores for the transosteal pins. The inner position of pins 186 is used when drilling for implantation of the four pin staple and the outer position of pins 188 is used for drilling during implantation of the two pin staple.

In use of the drill guide assembly according to the present invention, for application of the staple 10 or 20, the initial step includes making a plaster mold of the arcuate front portion of the mandibular lower jaw of

the patient and a clear plastic template 190 (Fig. 10) corresponding to the gum portion of the denture. The template 190 is then bored at two spaced locations to form apertures 192 at a predetermined distance such as to be clear of and between the exposed nerve centers on both sides of the jaw bone. The spacing between the apertures 192 in the template 190 is intended to correspond to the actual spacing of the two director rods 182. The spacing of the apertures 192 is selected to correspond to either the inner position pins 186 or outer position pins 188 of the yoke. The mounting alignment of the staple can be selected and checked for accuracy by attaching the director rods 182 to the apertures 192 of the template which is positioned on the jaw.

With more particular reference to Fig. 10, the drill guide assembly 110 is then aligned with the plane guide 116 in position on the lower side of the jaw bone of the patient after first pulling back the tissue around the portions of the jaw bone. The plane guide 116 of the drill guide assembly 110 is adjusted such as to abut against the underside of the curved front portion of the jaw bone to accept a portion of the jaw bone in the aperture 130 of the loop 124.

The drill guide assembly 110 is aligned on the jaw bone with the apertures 160 as close to parallel as possible with the axis of compression of the jaw. The alignment is limited by the shape of the jaw bone. That is, the mounting axis must extend through a sufficient portion of the jaw bone to support the transosteal pins and provide sufficient bone to accept the lag screws 14. It has been found that the mounting axis may be generally within 5 to 10^{o} of the axis of compression of the jaw. However, a portion of the inferior border of the jaw bone must be removed to form the mating surface 44 to provide a base for the compression of the lag screws and prevent

displacement of the staple.

After alignment, the protruding portion of the jaw bone is ground flat to provide the mating surface 44 by utilizing the guide surface 134 of the plane guide 116 and the burring tool as described above and shown in Fig. 4.

The barrel of the drill guide is then positioned to determine whether there is sufficient clearance for the teeth around the mating surface. In the event there is insufficient clearance, additional grooves 156 and 158 may be formed with a grinding tool as set forth above and shown in Fig. 12. After sufficient clearance is provided to align the flat surface 152 of the barrel 144 with the mating surface 44, tne teeth 156 of the barrel, in attached position, bite into the jaw bone to prevent lateral or rotational displacement of the drill guide assembly during the drilling operation.

After the drilling chamber 118 has been attached to the lower mandibular jaw bone 12 of the patient as described above, a drill, indicated at 162 in Fig. 6, of the proper size is selected to first drill the throughbores 40 in the jaw bone which are adapted to receive the transosteal pins 28 of the staple. As set forth above, a set of sleeves of proper inner diameter is slid into each aperture 160 of the barrel 144 in the positions 1, 3, 5 and 7 on the four pin staple and positions 2 and 6 for the two pin staple.

After the first throughbore 40 is drilled through the mandibular jaw bone by guidance of the drill through an appropriate sleeve in the drilling chamber, a rod 174 of proper diameter is inserted through the aperture 160 and through the throughbore 40 which has been drilled through the jaw bone for the purpose of further anchoring the drill guide assembly 110 in its previously located position on the jaw bone to avoid

accidental displacement during drilling of the remainder of the throughbores. The second throughbore is then similarly drilled through the jaw bone by utilization of the opposite outer end aperture 160 in the barrel of the drilling chamber and another rod 174 of proper diameter is inserted through the aperture 160 and the drilled throughbore 40 in the jaw bone whereby the drill guide assembly 110 is now anchored at two spaced points to positively prevent any displacement.

Thereafter, the remainder of the throughbores 40 are drilled, if necessary. The blind bores 42 are drilled on the jaw bone 10 for insertion of the lag screws 14 of the staple, utilizing a drill of different size and a sleeve having a corresponding inner diameter. The sleeve is inserted in apertures corresponding to positions 2, 4 and 6. The drill bit has the stop 172 at a proper distance from its pointed tip, as is commonly known in drilling blind bores. Thus, as previously explained, the blind bores 42 for the lag screws of the staple do not extend all the way through the mandibular jaw bone 12. Employing a drill of slightly larger diameter and a sleeve having an appropriate inner diameter, another set of blind bores is formed coaxially with the first set of blind bores for counter-sinking the lag screws 16.

In the case of the mandibular jaw having an anterior mandible too small to allow proper drilling of holes for pins at positions 1 and 7, a two transosteal pin staple 10 is required. The two pin staple 10, as shown in Fig. 1, has a transosteal pin at the 2 and 6 positions and the shorter threaded pin 132 in position 4. Two circular openings 30 for two lag screws 14 are positioned at the 3 and 5 positions.

After the throughbores 40 have been drilled, a depth gauge 250, as shown in Fig. 21, having a measuring

rod 252 and a movable cylinder 254 and a spacer 251 is provided to determine the length of the transosteal pins needed to penetrate the jaw bone. The measuring rod 250 has the same diameter and length as the transosteal pin from the compression staple. Each of a plurality of marks 259 are spaced apart axially on the measuring rod 252. The marks are spaced at 1 mm intervals, and extend from the upper end 256 of the measuring rod 252. The spacer has a handle 253 and a slot 255 for accepting the measuring rod. The cylinder 254 is slidably movable along the measuring rod 252. A set screw 258 may be advanced radially inwardly through the cylinder to contact the measuring rod 252 to lock the cylinder 254 in position.

As shown in Fig. 21, the length of the transosteal pin is then determined by inserting the measuring rod 252 through the throughbore 40 in the mandible and gingival tissue for the transosteal pins. The measuring rod is passed upwardly from the inferior border of the mandible until it reaches the gingival crest. This is noted by an assistant surgeon who is palpitating the intraoral entry cite of the twist drill with his finger. The spacer 251 is positioned against the inferior border of the mandible with the measuring rod in the slot 255 of the spacer. The surgeon then moves the cylinder 254 against the spacer 251 and tightens the set screw 258 to lock the cylinder in position. The measuring rod is then removed from the throughbore.

The transosteal pins of the staple are then shortened by notching the pins with a diamond cutting wheel 270 as shown in Fig. 23. The transosteal pins are held in position during shortening by a clamping rack 272. As shown in Fig. 22, the clamping rack has a first arm 274 having a concave surface 276 and a second arm 278

having a complimentary convex surface 280. The concave and convex surfaces have an arc equivalent to the arc "A-A" of the transosteal pins (Fig. 18). The arms 274 and 278 are pivotally joined together at one end by a pin 282 and may be secured at the other ends by a screw 284. The screw may be threaded through arm 278 into a bore 286 to lock the arms in a closed or clamped position.

Six chambers 288 corresponding to the positions 1, 2, 3, 5, 6 and 7 of the compression staple are bored axially through arms. The chambers 288 extend axially through the concave and convex surfaces to form semicircular surfaces in each surface. The chambers 288 have a diameter equal to the diameter of the transosteal pins and are thus positioned to accept either the four transosteal pins of the four pin staple or the two transosteal pins of the two pin staple. A bore 289 is formed in arm 274 for accepting the measuring rod.

The staple is then positioned with the transosteal pins extending through the holes 288 of the clamping rack 272 and the convex and concave curved surfaces are drawn together by tightening the locking screw to clamp the pins in the holes 288 as shown in Fig. 23. The chambers preferably have an axial length of 9mm such that when the rack is used with the smooth end staple, the entire threaded portion of the transosteal pins may be received within the chamber to protect the threads.

The upper end of the depth gauge 256 is inserted through the bore 289 in the direction of the base of the staple with the cylinder 258 contacting the arm 274. The staple is then positioned with the base contacting the upper end of the measuring rod and the screw 284 is tightened to lock the staple in position.

The spacer 251 is then placed over the transosteal pin on the clamping rack to protect the

clamping rack 272 from contact with a diamond cutting wheel 270 which is used to notch the transosteal pin. The handle 253 extends from the spacer to facilitate positioning of the spacer. The spacer has a predetermined thickness equal to the length of the transosteal pin extending over the gingiva. In the case of the smooth surfaced staple, the spacer is 5 mm. For the fully threaded staple, the spacer thickness is selected to correspond to a length for accepting the sleeve nut.

After each transosteal pin has been notched, a breaking tool 292 having a cylinder 294 and handle 296 is used to break the excess length portion 298 from the pin. The cylinder 294 has an inner diameter slightly larger than the diameter of the transosteal pin to accomodate the pin therein. The handle 296 is forced downwardly to pivot the excess length portion of the transosteal pin at the notch and to break or snap the excess length portion of the transosteal pin from the staple. After the excess length portion of each pin is removed, any unevenness on the end of the pin may be removed with a deburring tool. The staple is then removed from the clamp by disengaging the locking screw 254 and pivoting open the arms. Once removed, the staple is ready to be inserted into the mandible. The clamping rack may be used with either the staple 20 or the smooth ended staple 220.

The staple is then implanted by pushing the transosteal pins 28 through the proper throughbores 40 in the jaw. The staple is positioned with the upper surface 24 of the base plate 22 in abutting contact with the mating surface 44 of the jaw. In order to properly position the staple, an implant driver (not shown) may be used to tap the plate against the mating surface 44. The staple may be malleted by a series of blows against the implant driver to completely seat against the mating

surface on the inferior border of the mandible.

With the staple 20 firmly seated, the lag screws 14 are inserted into the blind bores 44 previously drilled. A Spline screwdriver (not shown) may be used to drive the self-tapping lag screws into position.

At this point, the surgeon may complete the surgical procedure. The cap nut or sleeve nut may be inserted later by a dentist or the surgeon may affix the proper nut.

In the case of the sleeve nut, the following procedure is followed. As set forth above, the trephine 58 is used to cut tissue away from the threads of the transosteal pin 28 through the gingiva. The cutting trephine has a sleeve 198 having a blade end 200 extending from a knurled handle 202. The sleeve is open to extend over the top of the transosteal pin while the blade end of the trephine has a sharpened edge to cut the tissue and enlarge the throughbore 40 extending through the gingiva to accept the sleeve of the sleeve nut. The handle 202 is gripped by hand to force the trephine along the transosteal pin.

The crest leveler tool 60 is used to level the top surface of the bone beneath the gingiva around the transosteal pin to permit the sleeve of the nut 16 to extend the proper distance through the gingiva. The crest leveler tool 60 has a sleeve 204 having an inner diameter to accept the transosteal pin and a serrated edge portion 206 at the end of the sleeve 204. A handle 208 extending from the sleeve is used to turn the crest tool to level the bone through engagement with the serrated edge 206.

The sleeve nut 16 or the cap nut 230 is then threaded into position with the bottom of the sleeve contacting the level top of the jaw bone. The sleeve nut 16 is then locked into position by threading the plug

into the top of the sleeve nut with a spline wrench, as set forth above.

In the case of the cap nut, the staple is inserted as above and the cap nuts are threaded or glued on the smooth extended portion of the transosteal pin. The cap nut may be locked in position with a wrench as set forth for the sleeve nut.

The day after surgery, the patient may be referred to a general dentist to have holes drilled in the old denture so that no material touches the sleeve nuts. After healing, a fixed or removable appliance may be fabricated for mounting on the compression staple. If a four pin transosteal staple is used, a fixed appliance 210 may be formed and mounted, as shown in Fig. 14. In this manner, a compression staple may be affixed to the jaw to provide a tight support for a fixed appliance.

CLAIMS:

1. A drill guide assembly for use with a drill and a grinding apparatus in the implantation of mandibular staples, said drill guide assembly being adapted for positioning and drilling a plurality of throughbores and a plurality of blind bores in spaced apart parallel alignment with a mounting axis through a mandibular jaw with a drill bit, said drill guide assembly comprising an elongated post having a pair of ends, a yoke member mounted to one of said pair of ends of said post for supporting said drill guide assembly in an upper position above said jaw, a plane guide detachably mounted to said post, said plane guide having a loop portion having a flat guide surface extending on a plane, said loop portion defining an aperture adapted for receiving a portion of said jaw with a protruding portion projecting beyond said guide surface within, whereby a planar mating surface may be formed on said jaw by grinding said projecting portion to extend along said plane, said planar mating surface extending normal to said mounting axis, means for guiding said drill bit for forming a plurality of apertures in said jaw bone, said means for guiding being detachably mounted to said post.

2. The drill guide assembly of claim 1, wherein said means for guiding comprises a drilling chamber having a flat upper surface and a plurality of teeth extending from said upper surface for lockingly engaging said jaw whereby said drilling chamber is held in position with respect to said jaw for drilling to prevent displacement of said drill bit along said jaw.

3. The drill guide assembly of claim 1 or 2, wherein said aperture of said loop portion has a curvilinear shape.

4. The drill guide assembly of claim 3, wherein said drilling chamber has a curvilinear barrel portion adapted to

be received within said aperture of said loop portion of said plane guide.

5. The drill guide assembly of any preceding claim, wherein said means for drilling further comprises a first plurality of drilling sleeves adapted for insertion into said drilling chamber, each of said first plurality of drilling sleeves having a first predetermined diameter, a second plurality of drilling sleeves adapted for insertion into said drilling chamber, each of said second plurality of drilling sleeves having a second predetermined inner diameter and means for locking said first and second plurality of drilling sleeves from rotation in said drilling chamber.

6. The drill guide assembly of claim 5, further comprising a pair of director rods mounted to said yoke member, said yoke member having two pairs of positioning pins, one pair of said two pairs of positioning pins defining an inner position for said director rods and the other of said two pairs of positioning pins defining an outer position adapted for accepting said pair of director rods.

7. The drill guide assembly of claim 5 or 6, wherein said means for locking comprises a plurality of keyways formed in said barrel portion of said drilling chamber, and wherein each of said first and second pluralities of drilling sleeves has a key portion extending from an end to be received in said keyway of said barrel portion.

8. A drill guide assembly, substantially as hereinbefore described with reference to Figs. 3 to 7, 10, 12 and 13 of the accompanying drawings.

Amendments to the claims have been filed as follows

1. A drill guide assembly for use with a drill and a grinding apparatus in the implantation of mandibular staples, said drill guide assembly being adapted for positioning and drilling a plurality of throughbores and a plurality of blind bores in spaced apart parallel alignment with a mounting axis through a mandibular jaw with a drill bit, said drill guide assembly comprising a post, a yoke member mounted on the upper end of said post, a plane guide adapted to be detachably and adjustably mounted on said post below said yoke member for use with said grinding apparatus in the removal of a portion of the lower part of said jaw to provide a flat engagement surface for the upper surface of a staple, said plane guide having a loop portion of curvilinear shape defining an aperture to receive the lower part of said jaw and a flat surface for guiding said grinding apparatus during removal of that part of said jaw projecting below said loop portion, a drilling chamber adapted to be removably and adjustably mounted on said post below said yoke member for guiding said drill bit in the formation of said bores and having a plurality of teeth extending upwardly from its curvilinear upper surface for engaging said jaw to lock the drilling chamber in position therein during drilling, first and second sets of drilling sleeves having first and second predetermined diameters respectively, said sleeves being adapted to be inserted and locked against rotation in said drilling chamber, and a pair of director rods for engagement with a template for protecting the upper jaw during drilling, said director rods depending from positioning pins on said yoke member, said yoke member having two pairs of positioning pins, one pin of each pair defining an inner position for the director rods and the other pin of each pair defining an outer position for the director rods.

2. The drill guide assembly of claim 1, wherein said drilling chamber has a curvilinear barrel portion adapted to be

received within said aperture of said loop portion of said plane guide.

3. The drill guide assembly of claim 2, wherein said means for locking comprises a plurality of keyways formed in said barrel portion of said drilling chamber, and wherein each of said first and second pluralities of drilling sleeves has a key portion extending from an end to be received in said keyway of said barrel portion.

4. A drill guide assembly, substantially as hereinbefore described with reference to Figs. 3 to 7, 10, 12 and 13 of the accompanying drawings.

3i

Patents Act 1977 `xaminer's report to the Comptroller under Section 17 (The Search Report)	Application number 9125893.9
Relevant Technical fields (i) UK Cl (Edition K) A5R RDJ RDN RDX (ii) Int Cl (Edition 5) A61C 8/00	Search Examiner MISS E M COLEMAN
Databases (see over) (i) UK Patent Office (ii) ONLINE DATABASE: WPI	Date of Search 29 JANUARY 1992

Documents considered relevant following a search in respect of claims 1-8

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2217994 A (SMALL)	1-8
&	US 4968250 (SMALL)	1-8
&	US 4917604 (SMALL)	1-8

SF2(p)

1me - c:\wp51\doc99\fil000523

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

Published 1992 at The Patent Office, Concept House, Cardiff Road, Newport, Gwent NP9 1RH. Further copies may be obtained from Sales Branch, Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, NP1 7HZ. Printed by Multiplex techniques ltd. St Mary Cray, Kent.